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03 JUN 2005
REC'D 30 MAY 2005

PCT

10/537385 PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 30794.94WOU1	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US03/21916	International filing date (day/month/year) 15 July 2003 (15.07.2003)	Priority date (day/month/year) 16 December 2002 (16.12.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): H01L 29/22, 51/40 and US Cl.: 438/99, 478, 584, 602, 787, 930, 933; 257/94, 103, 614, 615, 761		
Applicant THE REGENTS OF THE UNIVERSITY OF CALIFORNIA		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 3 sheets, including this cover sheet.
☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

- This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 06 May 2004 (06.05.2004)	Date of completion of this report 30 March 2005 (30.03.2005)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/ US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Donghee Kang Telephone No. 571-272-1656

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US03/21916

I. Basis of the report**1. With regard to the elements of the international application:***

- ☒ the international application as originally filed.
- ☒ the description:
pages 1-14 as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.
- ☒ the claims:
pages NONE, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages 15-17, filed with the letter of 10 November 2004 (10.11.2004)
- ☒ the drawings:
pages 1-7, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.
- ☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages None
- ☒ the claims, Nos. 18
- ☒ the drawings, sheets/fig None

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/21916

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims <u>1-17</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>1-17</u>	YES
	Claims <u>NONE</u>	NO
Industrial Applicability (IA)	Claims <u>1-17</u>	YES
	Claims <u>NONE</u>	NO

2. CITATIONS AND EXPLANATIONS

Claims 1-17 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a whole the claimed limitation either taken alone or in combination.

----- NEW CITATIONS -----

WHAT IS CLAIMED IS:

1. A method for forming a planar, non-polar gallium nitride (GaN) film on a substrate, comprising:

- (a) loading a substrate into a reactor;
- 5 (b) heating the reactor to a growth temperature;
- (c) reducing the reactor's pressure to a desired deposition pressure, wherein the desired deposition pressure is below atmospheric pressure;
- (d) initiating a gaseous hydrogen chloride (HCl) flow to a gallium (Ga) source to begin growth of the GaN film directly on the substrate, wherein the gaseous HCl
- 10 reacts with the Ga to form gallium monochloride (GaCl);
- (e) transporting the GaCl to the substrate using a carrier gas that includes at least a fraction of hydrogen (H₂), wherein the GaCl reacts with ammonia (NH₃) at the substrate to form the GaN film; and
- (f) after a desired growth time has elapsed, interrupting the gaseous HCl flow,
- 15 returning the reactor's pressure to atmospheric pressure, and reducing the reactor's temperature to room temperature.

2. The method of claim 1, wherein the substrate is a sapphire substrate,

20 3. The method of claim 1, wherein the substrate is coated with a thin film of GaN, aluminum nitride (AlN), or aluminum gallium nitride (AlGa_{0.5}N).

4. The method of claim 2, wherein the substrate is coated with a nucleation layer deposited either at low temperatures or at the growth temperature.

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5. The method of claim 1, wherein the substrate is a free-standing GaN, aluminum nitride (AlN), or aluminum gallium nitride (AlGa_{0.5}N) film.

6. The method of claim 1, further comprising evacuating the reactor and backfilling the reactor with purified nitrogen (N_2) gas to reduce oxygen and water vapor levels therein before heating the reactor.
- 5 7. The method of claim 1, further comprising nitridating the substrate, at a temperature in excess of 900°C ;
8. The method of claim 7, wherein the nitridating step comprises adding anhydrous ammonia (NH_3) to a gas stream in the reactor to nitride the substrate.
- 10 9. The method of claim 1, wherein the heating step (b) comprises heating the reactor to the growth temperature of approximately 1040°C , with a mixture of hydrogen (H_2) and nitrogen (N_2) flowing through all channels in the reactor.
- 15 10. The method of claim 1, wherein the gaseous HCl reacts with the Ga at a temperature in excess of 600°C to form the $GaCl$.
11. The method of claim 1, wherein the desired deposition pressure ranges from 5 to 100 Torr.
- 20 12. The method of claim 1, wherein the desired deposition pressure is approximately 76 Torr.
13. The method of claim 1, wherein typical growth rates for the GaN film
- 25 range from 1 to $50\text{ }\mu\text{m}$ per hour.
14. The method of claim 1, wherein the interrupting step (f) further comprises including anhydrous ammonia (NH_3) in a gas stream to prevent decomposition of the GaN film during the reduction of the reactor's temperature.

15. The method of claim 1, wherein the interrupting step (f) further comprises cooling the substrate at a reduced pressure between 5 and 760 Torr.

5 16. A device manufactured using the method of claim 1.

17. The device of claim 16, wherein the device is a laser diode, light-emitting diode or transistor.